Steelhead Pre-screen Loss in Clifton Court Forebay

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INTRODUCTION

Clifton Court Forebay is a regulating reservoir for the State Water Project's Banks Pumping Plant at the head of the California Aqueduct, which is located in the Sacramento-San Joaquin Delta. Clifton Court Forebay is tidally filled by water from nearby Old River through the operation of five radial gates. When the radial gates are opened, fish are entrained within Clifton Court Forebay. The entrained fish can either emigrate back through the radial gates and into Old River or the entrained fish can make a minimum 2.1 mile crossing of the forebay before reaching the John E. Skinner Delta Fish Protective Facility, which screens and returns fish to the estuary. Losses of fish between the radial gates and the fish protection facility, termed pre-screen loss, include predation by fish and birds. The NOAA Fisheries OCAP biological opinion (2004) required investigations to (1) quantify predation losses on juvenile steelhead within Clifton Court Forebay, and (2) identify potential management actions to reduce predation mortality of juvenile steelhead. The steelhead pre-screen loss investigation is a pre-condition to increasing State Water Project (SWP) mean monthly export rates from 6680 to 8,500 cfs.

OBJECTIVES

- Evaluate predation losses of juvenile steelhead during passage through Clifton Court Forebay and evaluate steelhead behavior and movement patterns.
- Evaluate the behavior and movement patterns of adult striped bass, the primary predatory fish species that could prey on juvenile steelhead within the forebay
- Identify physical locations and environmental/operational factors that contribute to increased vulnerability of juvenile steelhead to predation within Clifton Court Forebay
- Determine the prevalence of avian predation within the forebay
- Develop quantitative estimates of pre-screen losses of juvenile steelhead within the Clifton Court Forebay

METHODS

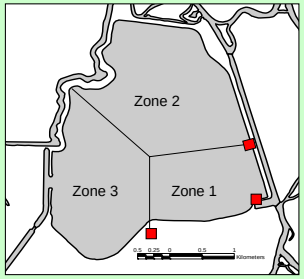
- A stratified mark-recapture experimental design was developed utilizing two complementary tagging technologies, acoustic tags and Passive Integrated Transponder (PIT) tags
- Pilot studies were conducted in 2005 and 2006, with the full-scale study conducted in 2007

Striped bass were captured and acoustic tagged in Clifton Court Forebay in 2005 and 2007

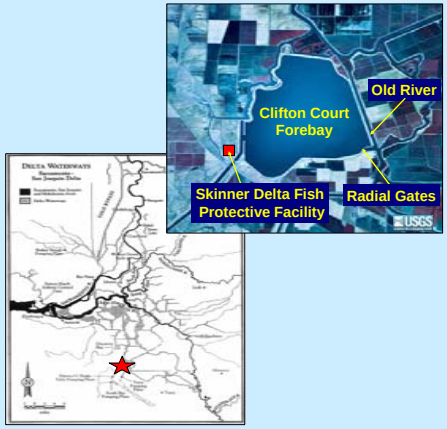
Surgical implantation of acoustic tag into juvenile steelhead abdominal cavity 2005 - 2007

2007 PIT tagging of juvenile steelhead

Live-car release of tagged steelhead immediately upstream of the radial gates to simulate entrainment.

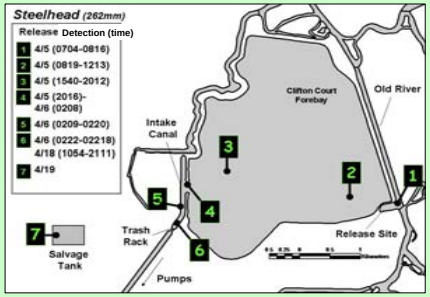


Avian point count zones within Clifton Court Forebay. The red squares denote observation stations for the 2007 field season.



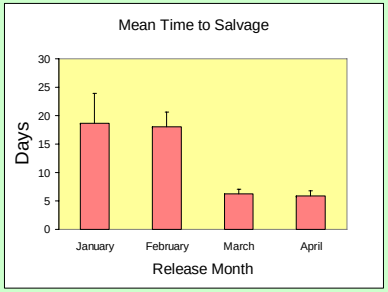
PRELIMINARY RESULTS

- In 2005, 13.5% of 30 acoustic tagged juvenile steelhead released at the radial gates were detected as having been salvaged at the fish protection facility.



Summary of a single juvenile steelhead's movement in 2005.

- In 2007, 12.8% of 922 PIT tagged juvenile steelhead released at the radial gates were salvaged and detected at the SWP release sites.



Time to salvage (Mean ± SE) for PIT tagged steelhead released daily over four months in 2007.

PRELIMINARY RESULTS CONTINUED

2007 Pre-screen loss calculations (Mean ± 95% CI) for 58 release groups of PIT tagged steelhead released at the radial gates (RG)

Raw (not adjusted for facility efficiency or detection efficiency):

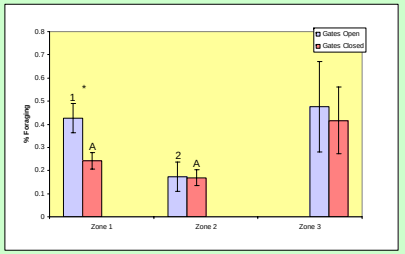
$$\left(1 - \left(\frac{\text{\# detected in salvage}}{\text{\# released}_{RG} - \text{emigration}}\right)\right) \times 100\% = \mathbf{87 \pm 2\%}$$

Adjusted for facility efficiency and detection efficiency:

$$\left(1 - \left(\frac{\text{\# detected in salvage}}{(\text{\# released}_{RG} - \text{emigration}) \times \text{detection efficiency} \times \text{facility efficiency}_{TR}}\right)\right) \times 100\% = \mathbf{82 \pm 3\%}$$

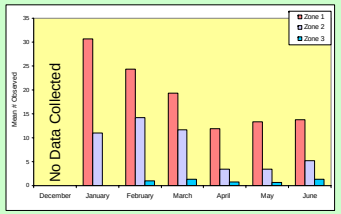
Note: Facility efficiency (74.5%) was measured via releases of PIT tagged steelhead released directly into the primary bays near the trash rack (TR) at the Skinner Fish Protection Facility during the 2007 field season. Detection efficiency (98.75%) was measured via eight tag detection efficiency tests during the 2007 field season. Emigration consisted of one PIT tagged steelhead detected in a Tracy Fish Collection Facility count.

AVIAN PREDATION STUDY RESULTS

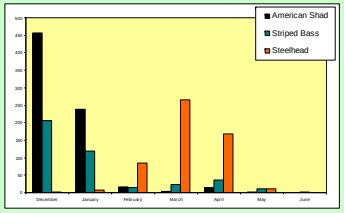


Gate operations significantly affected % foraging (mean ± SE) of Double Crested Cormorants in zone 1 as tested by a two-way ANOVA. Additionally, a significant difference in % foraging was found between zone 1 and zone 2 when the radial gates were open.

Note: The foraging values are percentage data that were arcsine transformed. A difference in letters or numbers denotes a significant difference ($P < 0.05$) between zones. The asterisk denotes a significant difference ($P < 0.05$) between gate operations in zone 1. Data for Zone 3 data were included for comparison purposes, but were not included in any statistical tests.



Mean monthly counts of Double Crested Cormorants in the Forebay by zone. Abundance in zone 1 decreased over time and coincided with a decrease in American shad and striped bass abundance in the salvage.



Monthly total salvage for American shad, striped bass and steelhead at the John E. Skinner Delta Fish Protective Facility. This only includes fishes between 100-300 mm FL.

ONGOING DATA ANALYSIS AND REPORT WRITING

- Test if there is a difference in pre-screen loss rates between day and night releases at the radial gates.
- Test if there is a difference in pre-screen loss rates due to water temperature.
- Analyze 2007 steelhead and striped bass movement rates within the study area.
- Test if there is a difference in movement rates due to water quality conditions and/or operational conditions.
- **Final Report Available Late-Summer of 2008**